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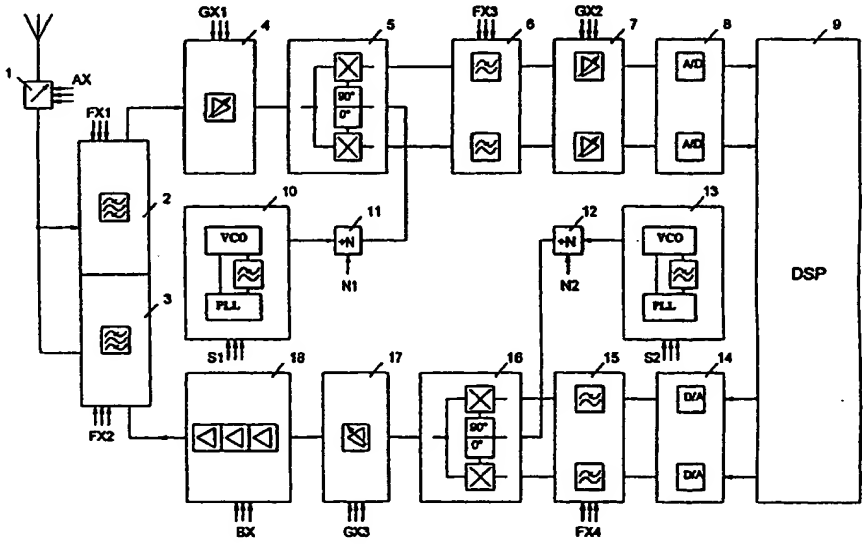

(57) Abstract

The invention pertains to a method and arrangement for transmitting and receiving RF signals associated with different radio interfaces of communication systems. The solution according to the invention uses a direct conversion based transceiver which substantially has got one receive signal branch and one transmit signal branch. Also, the mixing frequencies of the different systems are generated by means of one and the same synthesizer. This is achieved by using an output frequency divider in connection with the synthesizer, and by performing the filtering corresponding to the system's channel bandwidth by means of a controllable low–pass filter operating at the baseband frequency.

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Method and arrangement for transmitting and receiving RF signals through various radio interfaces of communication systems

The invention relates to a method and arrangement for transmitting and receiving RF signals associated with various radio interfaces of communication systems. The invention finds particular utility in transceivers of general-purpose mobile stations.

Mobile communication systems are developing and expanding rapidly which has lead to a situation in which there are in many areas systems complying with several different standards. This has brought about a need for mobile stations that can be used in more than one system. Good examples are the digital systems called GSM (Global System for Mobile communications) and DCS (Digital Cellular System), which operate on different frequency bands but have otherwise similar radio interfaces. In addition, the modulation, multiplexing and coding schemes used may be different. The systems mentioned above use the time division multiple access (TDMA) method; other methods include the frequency division multiple access (FDMA) and code division multiple access (CDMA).

One possible way of making a mobile station capable of operating in multiple systems is to have in the mobile station completely separate signal paths for each system. This, however, would lead to an unreasonable increase in the mobile station size and manufacturing costs. Therefore, the goal is to design a mobile station in which the differences relating to the radio interfaces of the various systems could be largely dealt with by means of programming, instead of having separate signal processing paths.

It is known e.g. from patent application document EP 653851 a transceiver arrangement using one local oscillator the frequency of which falls between the lower operating frequency band and the higher operating frequency band such that one and the same intermediate frequency (IF) can be used for both operating frequency bands. However, the disadvantage of such a solution is that the necessary IF stages make the implementation rather complex, and the manufacturing costs of the device will be high because of the great number of components. Furthermore, the IF stages require filters in order to eliminate spurious responses and spurious emissions. In addition, channel filtering at the intermediate frequency sets great demands on the IF filters.

In a direct-conversion, or zero-IF, receiver the radio-frequency (RF) signal is directly converted into baseband without any intermediate frequencies. Since no IF

stages are needed, the receiver requires only a few components, therefore being an advantageous solution for general-purpose mobile stations which have multiple signal branches for different systems. To aid in understanding the problems relating to the direct conversion technique and prior art it is next described in more detail a prior-art solution.

Fig. 1 shows a direct conversion based arrangement for realizing a dual frequency band transceiver, known from the Finnish Patent document FI 100286. Depending on the receive frequency band, a RF signal received by an antenna is coupled by means of switch 104 either to a first receive branch (DCS) or second receive branch (GSM). If the received signal is in the DCS frequency band, it is conducted to bandpass filter 106, low-noise amplifier (LNA) 108 and bandpass filter 110. After that the signal is brought to block 112 which produces signal components having a 90-degree phase difference. The in-phase component I and quadrature component Q are further conducted by means of switches 114 and 134 to mixers 116 and 136. The mixers get their mixing signals from a DCS synthesizer 140 the frequency of which corresponds to the received carrier frequency so that the mixing produces the in-phase and quadrature components of the complex baseband signal. The baseband signal is further processed in the receive (RX) signal processing unit, block 139.

If the signal received is a GSM signal, switch 104 directs the received signal to the GSM branch which comprises, connected in series, bandpass filter 126, low-noise amplifier 128, bandpass filter 130 and phase shifter 132 which generates two signals with a mutual phase difference of 90 degrees. The signals are further conducted by means of switches 114 and 134 to mixers 116 and 136 where the mixing frequency is now determined by a signal coming from the GSM synthesizer 150 via switch 161. The signals produced by the mixers are further conducted to the baseband RX signal processing unit 139.

The DCS synthesizer comprises in a known manner a phase-locked loop (PLL) which includes a voltage-controlled oscillator (VCO) 141 the output signal of which is amplified at amplifier 146 thus producing the synthesizer output signal. The frequency of the signal from oscillator 141 is divided by an integer Y in divider 142 and the resulting signal is conducted to phase comparator 143. Similarly, the frequency of the signal generated by reference oscillator 158 is divided by an integer X in divider 144 and conducted to phase comparator 143. The phase comparator produces a signal proportional to the phase difference of said two input signals, which signal is conducted to a low-pass filter (LPF) 145 producing a filtered signal that controls the voltage-controlled oscillator 141. The phase-locked

loop described above operates in a known manner in which the output frequency of the synthesizer becomes locked to the frequency coming to the phase comparator from the reference frequency branch. The output frequency is controlled by varying the divisor Y.

The GSM synthesizer 150 comprises a voltage-controlled oscillator 150, amplifier 156, dividers 152 and 154, phase comparator 153 and a low-pass filter 155. The GSM synthesizer operates like the DCS synthesizer described above, but the output frequency of the GSM synthesizer corresponds to GSM frequency bands.

In the transmitter part, a baseband complex transmit (TX) signal is processed in a TX signal processing unit wherefrom the in-phase and quadrature components of the signal are conducted to mixers 162 and 182 that produce a carrier-frequency signal by multiplying the input signal by the mixing signal. If the transmission is at the DCS frequency, switch 161 selects the DCS synthesizer's output signal as the mixing signal. The carrier-frequency signal is conducted through switch 164 to the DCS branch where a 90-degree phase shift is first produced between the in-phase component and quadrature component, and the resulting signals are then summed, block 166. The resulting DCS signal is conducted to bandpass filter 168, amplifier 170, and bandpass filter 172. The RF signal thus produced is further conducted to the antenna 102 via switch 180.

If the transmission is at the GSM frequency, the output signal of the GSM synthesizer is used as the mixing signal. The resulting carrier-frequency signal is conducted to the GSM branch in which it is processed in the same manner as in the DCS branch blocks 186, 188, 190 and 192. The RF signal thus produced is conducted to the antenna 102 via switch 180. One and the same antenna 102 can be used in both transmission and reception if the TX and RX circuits are coupled to the antenna through a duplex filter, for example. If the apparatus is designed to operate in two or more frequency bands, it needs separate filters for each frequency band.

The circuit arrangement described above has, however, some disadvantages. First, separate carrier-frequency signal branches in the receiver and in the transmitter add to the complexity, size and manufacturing costs of the transceiver. Second, each operating frequency band needs a separate synthesizer of its own.

An object of the invention is to provide a simple solution for realizing a programmable transceiver operating in a plurality of systems in such a manner that the aforementioned disadvantages related to the prior art can be avoided.

In the direct conversion based transceiver according to the invention signal processing can be performed using one and the same signal processing line regardless of the system. This is achieved using the signal processing steps set forth below.

The method according to the invention for processing signals received from different radio interfaces of communication systems is characterized in that it comprises steps in which

- a carrier-frequency signal is received from a radio interface,
- the carrier-frequency signal is bandpass-filtered,
- the filtered carrier-frequency signal is amplified,
- an RX mixing signal at the receive frequency is generated,
- a complex baseband signal is generated from the received carrier-frequency signal by mixing it with the RX mixing signal,
- the baseband signal generated is low-pass-filtered,
- the baseband signal generated is amplified,
- the baseband signal is converted digital, and
- the baseband signal converted digital is processed to produce an information signal encoded and modulated into the received signal.

The method according to the invention for processing signals transmitted to different radio interfaces of communication systems is characterized in that it comprises steps in which

- a digital baseband quadrature signal is generated on the basis of the information signal to be transmitted,
- the digital baseband signal is converted analog,
- a TX mixing signal at the transmit frequency is generated,
- a carrier-frequency transmission signal is generated from the baseband signal by mixing it with the TX mixing signal,
- the carrier-frequency signal generated is amplified, and
- the transmission signal is sent to the radio interface.

The direct-conversion receiver according to the invention operating at different interfaces of communication systems is characterized in that it comprises

- antenna means for receiving a radio-frequency signal,
- bandpass filter for filtering a carrier-frequency signal,
- first RX amplifier for amplifying the filtered carrier-frequency signal,
- means for generating an RX mixing signal at the receive frequency,
- mixing means for generating a complex baseband signal from the received signal using the RX mixing signal,

- low-pass filter for filtering the baseband signal,
- second amplifier for amplifying the baseband signal,
- analog-to-digital converter for converting the baseband signal digital, and
- means for processing the baseband signal converted digital to produce an information signal encoded and modulated into the received signal.

The direct-conversion transmitter according to the invention operating at different radio interfaces of communication systems is characterized in that it comprises
- means for generating a digital baseband quadrature signal on the basis of the information signal to be transmitted,
- digital-to-analog converter for converting the baseband transmission signal analog,
- synthesizer for generating a TX mixing signal at the transmit frequency,
- mixing means for producing a signal at the carrier frequency from the baseband transmission signal using the TX mixing signal,
- TX amplifier for amplifying the signal at the carrier frequency, and
- antenna means for transmitting the amplified transmission signal at the carrier frequency.

Other preferred embodiments of the invention are described in the dependent claims.

In the present invention, signal band limiting is advantageously performed at the baseband frequency so that there is no need for "steep" filters and, therefore, system-specific filter lines. Filtering can thus be performed as low-pass filtering using a filter with a controllable cut-off frequency. This way, it is possible to completely avoid separate system-specific channel filtering circuits.

To enable the generation of mixing frequencies of the different operating frequency bands by one and the same synthesizer it is advantageously used frequency division of the synthesizer output signal. If the synthesizer's operating frequency is set higher than the frequencies used in the systems, it is possible to generate, in conjunction with the synthesizer frequency division, two mixing signals with a 90-degree phase difference, thus avoiding the need for phase shifters on the signal line and achieving a good phase accuracy.

Using the solution according to the invention it is possible to realize a general-purpose transceiver which is considerably simpler and more economical to manufacture than prior-art solutions. The circuit arrangement according to the invention requires only one TX signal branch and one RX signal branch. Moreover, one and

the same synthesizer may be used to generate the mixing signals. Furthermore, there is no need for channel filters operating at the radio frequency. Therefore, the circuitry can be easily integrated. Since the invention involves only a few components, the advantages of the transceiver according to the invention include small size and low power consumption.

The invention will now be described in more detail with reference to the accompanying drawing wherein

Fig. 1 shows a block diagram of a dual-band direct-conversion transceiver according to the prior art,

Fig. 2 shows in the form of block diagram a solution according to the invention for a direct-conversion transceiver operating in multiple systems.

Fig. 1 was already discussed in conjunction with the description of the prior art. Next, a transceiver according to the invention will be described, referring to Fig. 2.

Fig. 2 shows in the form of block diagram a transceiver according to the invention. A RF signal received through an antenna is conducted via matching circuits 1 to controllable bandpass filters 2. The matching circuits 1 may advantageously be controllable (AX) with respect to the operating frequency band. A controllable bandpass filter 2 may be advantageously realized using a plurality of bandpass filters so that the RF signal is conducted via switch elements controlled by a control signal FX1 from the matching circuit 1 to the bandpass filter that corresponds to the selected operating frequency band. The bandpass filter may also be realized so as to be adjustable and tuneable by means of programming. The bandpass filtered carrier-frequency signal is further conducted to a low-noise amplifier 4, the gain of which is advantageously controllable. The control signal is marked GX1 in the drawing. In addition to amplifier 4, it is also possible to have integrated amplifiers in connection with the bandpass filters.

The signal is then conducted to a mixer 5 in which the carrier-frequency signal is mixed with an RX mixing signal at the receive frequency to produce a baseband quadrature signal. The RX mixing signal is advantageously generated by a synthesizer 10 the output signal frequency of which is divided by a divider 11 so as to correspond to the selected receive frequency. The synthesizer 10 operates in a similar manner as the synthesizers depicted in Fig. 1. Thus it comprises a voltage-controlled oscillator VCO which produces an output signal. The frequency of the VCO output signal is divided by S1 in a divider in the phase-locked loop PLL. The

resulting signal is conducted to a first input of a phase comparator in the phase-locked loop. Similarly, the frequency of a signal generated by a reference oscillator in the phase-locked loop PLL is divided by an integer and conducted to a second input of the phase comparator. The phase comparator produces a signal which is proportional to the phase difference of the two input signals and conducted to a low-pass filter, and the filtered signal then controls the voltage-controlled oscillator VCO. The output frequency is controlled by varying the divisor S1.

The synthesizer output signal is divided in divider 11 by N1 so that the RX mixing signal corresponds to the selected receive frequency band. The output frequency of the synthesizer may be e.g. in the 4-GHz band, so that with 2-GHz systems the synthesizer output frequency is divided by two, and with 1-GHz systems it is divided by four (N1). This way, systems operating in the 1-GHz and 2-GHz bands can be covered with a synthesizer the operating frequency band of which is narrow with respect to the operating frequency.

To produce a quadrature baseband signal the mixer needs two mixing signals with a phase shift of 90 degrees. Phase-shifted components may be produced by a phase shifter in connection with the mixer or they may be produced as quotients generated already in the frequency divider 11, thus achieving an accurate phase difference. Therefore, it is advantageous to use a synthesizer operating frequency which is a multiple of the highest system frequency.

The in-phase component I and quadrature component Q from the mixer 5 are further conducted to low-pass filters 6. The higher cut-off frequency of the low-pass filters is advantageously controllable with control signal FX3. Thus the filtering can be performed at a bandwidth corresponding to the selected radio interface, and since the filtering is performed at baseband, it is easy to get the filtering function steep. Also, no strict demands are set on the bandpass filtering (2) of the RF signal.

The baseband signal is further conducted to a gain control block 7 which possibly includes an offset voltage correction block. On the other hand, considering the broad bandwidth of the CDMA system, the offset voltage can easily be removed by high-pass filtering. The amplifier advantageously realizes automatic gain control (AGC). Finally, the signal is converted digital in an analog-to-digital converter 8, and the digital baseband signal is further processed in a digital signal processor (DSP) 9. Channel filtering may also be performed digitally in the DSP, whereby the low-pass filtering of the baseband signal may be performed using a fixed cut-off

frequency. Then, however, the dynamics of the analog-to-digital converter must be considerably better.

In the transmitter part, a quadrature baseband signal is first digitally generated in block 9 on the basis of the information signal to be sent. The components of the digital signal are converted analog by digital-to-analog converters 14, whereafter the analog signals are low-pass filtered by low-pass filters 15. Advantageously, the cut-off frequency of the low-pass filters can be controlled with control signal FX4 so as to correspond to the specifications of the selected radio interface.

A TX mixing signal at the carrier frequency is generated by a synthesizer 13 and divider 12. The synthesizer 13 operates in a similar manner as the synthesizer 10 in the receiver part. Moreover, the synthesizers may share a reference oscillator. The frequency of the synthesizer output signal is controlled with control signal S2 within the synthesizer's operating frequency range. The frequency of the output signal from synthesizer 13 is divided in divider 12 so as to correspond to the selected transmission frequency band. Components phase-shifted by 90 degrees are generated from the TX mixing signal in order to perform complex mixing in mixer 16. The phase-shifted components may be generated in the same way as in the receiver part.

The signal at the carrier frequency is then amplified in an amplifier 17, the gain of which is advantageously controllable in order to set the transmission power and realize automatic gain control (AGC). The control signal is marked GX3 in Fig. 2. The signal is then conducted to a power amplifier 18. The operating frequency band of the power amplifier is advantageously selectable with control signal BX. This can be achieved e.g. such that the amplifier comprises partly separate signal lines for the different operating frequency bands.

The RF signal generated is filtered by a bandpass filter 3. The pass band of the bandpass filter is advantageously controllable with control signal FX2. This can be realized in the same way as in the receiver part. The receiver and transmitter part filters 2 and 3 are advantageously realized in duplex filter pairs for each transmit-receive frequency band associated with a given system. The filters may advantageously be surface acoustic wave (SAW) or bulk acoustic wave (BAW) filters so that several filters with their switches may be attached to one component.

The control signals in the mobile station transceiver according to Fig. 2 are preferably generated in a control block of the mobile station which advantageously comprises a processing unit such as a microprocessor. The control block generates

the signal on the basis of a system switch instruction input from the keypad of the mobile station, for example. System selection may be e.g. menu-based so that the desired system is selected by choosing it from a displayed menu by pressing a certain key on the keypad. The control block then generates the control signals that correspond to the selected system. The system switch instruction may also come via the mobile communication system in such a manner that data received from the system may include a system switch instruction on the basis of which the control block performs the system switch. Advantageously, a control program is stored in a memory unit used by the control block, which control program monitors the received data and, as it detects a system switch instruction in the data, gives the control block an instruction to set the control signals into states according to the selection instruction.

The implementation of the blocks described above is not illustrated in more detail as the blocks can be realized on the basis of the information disclosed above, applying the usual know-how of a person skilled in the art.

Above it was described embodiments of the solution according to the invention. Naturally, the principle according to the invention may be modified within the scope of the invention as defined by the claims appended hereto, e.g. as regards implementation details and fields of application. It is especially noteworthy that the solution according to the invention may be well applied to communication systems other than the mobile communication systems mentioned above. Apart from the cellular radio interface proper, the solution may be used to realize e.g. a GPS receiver for the location of a mobile station or other apparatus. Furthermore, the operating frequencies mentioned are given by way of example only, and the implementation of the invention is in no way restricted to them.

It is also noteworthy that the solution according to the invention may be applied to all current coding techniques such as the narrow-band FDMA (Frequency Division Multiple Access) and TDMA (Time Division Multiple Access), as well as the broadband CDMA (Code Division Multiple Access) technique. In addition, the solution according to the invention may be used to realize an FM (Frequency Modulation) receiver.

Below is a table listing some of the so-called second generation mobile communication systems to which the present invention may be applied. The table shows the most important radio interface related characteristics of the systems.

CELLULAR SYSTEM	AMPS	IS-54/-136	IS-95 US CDMA	GSM Global System for Mobile Communications	DCS 1800	PDC Personal Digital Cellular	DECT Digital European Cordless Telephone	PHS Personal Handy Phone System
RX FREQ. (MHz)	869-894	869-894	869-894	935-960	1805-1880	810-826, 1429-1453	1880-1900	1895-1918
TX FREQ. (MHz)	824-849	824-849	824-849	890-915	1710-1785	940-956, 1477-1501	1880-1900	1895-1918
RF BANDWIDTH	25 MHz	25 MHz	25 MHz	25 MHz	75 MHz	16 MHz 24 MHz	20 MHz	23 MHz
MULTIPLE ACCESS METHOD	FDMA	TDMA/ FDMA	CDMA/FDMA	TDMA/FDMA	TDMA/ FDMA	TDMA/FDMA	TDMA/ FDMA	TDMA/ FDMA
DUPLEX METHOD	FDD	FDD	FDD	FDD	FDD	FDD	TDD	TDD
NUMBER OF CHANNELS	832	832, 3 users/ channel	20, 798 users/ channel	124, 8 users/channel	374, 8 users/ channel	1600, 3 users/ channel	10, 12 users/ channel	300 4 users/ channel
CHANNEL SPACING	30 kHz	30 kHz	1250 kHz	200 kHz	200 kHz	25 kHz	1.728 MHz	300 kHz
MODULATION	FM	π/4 DQPSK	QPSK/ OQPSK	GMSK 0.3 Gaussian filter	GMSK 0.3 Gaussian filter	π/4 DQPSK	GFSK 0.3 Gaussian filter	π/4 DQPSK
CHANNEL BIT RATE	-	48.6 kb/s	1.2288 Mb/s	270.833 kb/s	270.833 kb/s	42 kb/s	1.152 Mb/s	384 kb/s

Below is another table listing some of the so-called third generation mobile communication systems to which the present invention may be applied. The table shows the most important radio interface related characteristics of the systems.

CELLULAR SYSTEM	WCDMA	
RX FREQ. (MHz)	2110 - 2170	1900 – 1920
TX FREQ. (MHz)	1920 – 1980	1900 – 1920
MULTIPLE ACCESS METHOD	CDMA	TDMA
DUPLEX METHOD	FDD	TDD
CHANNEL SPACING	5 MHz	5 MHz
MODULATION	QPSK	
CHANNEL BIT RATE	144 kb/s in rural outdoor, 500 kb/ s in urban outdoor and up to 2 Mb/s in indoor	

Claims

1. A method for processing signals received from different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a carrier-frequency signal is received from a radio interface,
- the signal at the carrier frequency is bandpass-filtered,
- the filtered signal at the carrier frequency is amplified,
- an RX mixing signal at the receive frequency is generated,
- a complex baseband signal is generated from the received carrier-frequency signal by mixing it with the RX mixing signal,
- the baseband signal generated is low-pass filtered,
- the baseband signal generated is amplified or attenuated prior to analog-to-digital conversion,
- the baseband signal is converted digital, and
- the baseband signal converted digital is processed so as to produce an information signal encoded and modulated into the received signal.

2. A method for processing signals transmitted to different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a digital baseband quadrature signal is generated on the basis of the information signal to be transmitted,
- the digital baseband signal is converted analog,
- a TX mixing signal at the transmit frequency is generated,
- a carrier-frequency transmission signal is generated from the baseband signal by mixing it with the TX mixing signal,
- the carrier-frequency signal generated is amplified, and
- the transmission signal is transmitted to the radio interface.

3. A direct-conversion receiver operating at different radio interfaces of communication systems, **characterized** in that it comprises
- antenna means for receiving a carrier-frequency signal from a radio interface,
- bandpass filter (2) for filtering the carrier-frequency signal,
- first receiver amplifier (4) for amplifying the filtered carrier-frequency signal,
- means (10, 11) for generating an RX mixing signal at the receive frequency,
- mixing means (5) for generating a complex baseband signal from the received signal by means of the RX mixing signal,
- low-pass filter (6) for filtering the baseband signal,
- second amplifier (7) for amplifying the baseband signal,
- analog-to-digital converter (8) for converting the baseband signal digital, and

- means (9) for processing the baseband signal converted digital so as to produce an information signal encoded and modulated into the received signal.

4. The receiver of claim 3, **characterized** in that it comprises means for selecting the pass band of the bandpass filter (2, FX1) such that it corresponds to the receive frequency.

5. The receiver of claim 3 or 4, **characterized** in that it comprises means for controlling the gain of said first amplifier.

6. The receiver of any one of claims 3 to 5, **characterized** in that the means (10, 11) for generating a mixing signal at the receive frequency comprises an RX synthesizer (10, S1) and controllable frequency divider (11, N1) for dividing the frequency of the output signal generated by the RX synthesizer.

7. The receiver of claim 6, **characterized** in that said frequency divider is arranged so as to divide the output signal of the RX synthesizer always by at least two in order to generate an RX mixing signal.

8. The receiver of any one of claims 3 to 7, **characterized** in that it comprises means (6, FX3) for controlling the cut-off frequency of low-pass filtering in order to perform channel filtering according to the selected radio interface.

9. The receiver of any one of claims 3 to 8, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

10. The receiver of any one of claims 3 to 9, **characterized** in that it comprises means (7, GX2) for controlling the gain of the second amplifier.

11. The receiver of any one of claims 3 to 10, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.

12. A direct-conversion transmitter operating at different radio interfaces of communication systems, **characterized** in that it comprises
- means (9) for generating a digital baseband quadrature signal on the basis of the information signal to be transmitted,
- digital-to-analog converter (14) for converting the baseband transmission signal analog,
- synthesizer (10, 11) for generating a TX mixing signal at the transmit frequency,

- mixing means (16) for producing a signal at the carrier frequency from the base-band transmission signal by means of the TX mixing signal,
- transmitter amplifier (7, 8) for amplifying the signal at the carrier frequency, and
- antenna means for transmitting the amplified transmission signal at the carrier frequency.

13. The transmitter of claim 12, **characterized** in that it comprises a controllable low-pass filter (15, FX4) for filtering a baseband transmission signal in order to perform channel filtering according to the radio interface selected.

14. The transmitter of claim 12 or 13, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

15. The transmitter of claim 12, 13 or 14, **characterized** in that the means (10, 11) for generating a TX mixing signal at the transmit frequency comprises a TX synthesizer (13, S2) and controllable frequency divider (12, N2) for dividing the frequency of the output signal generated by the TX synthesizer.

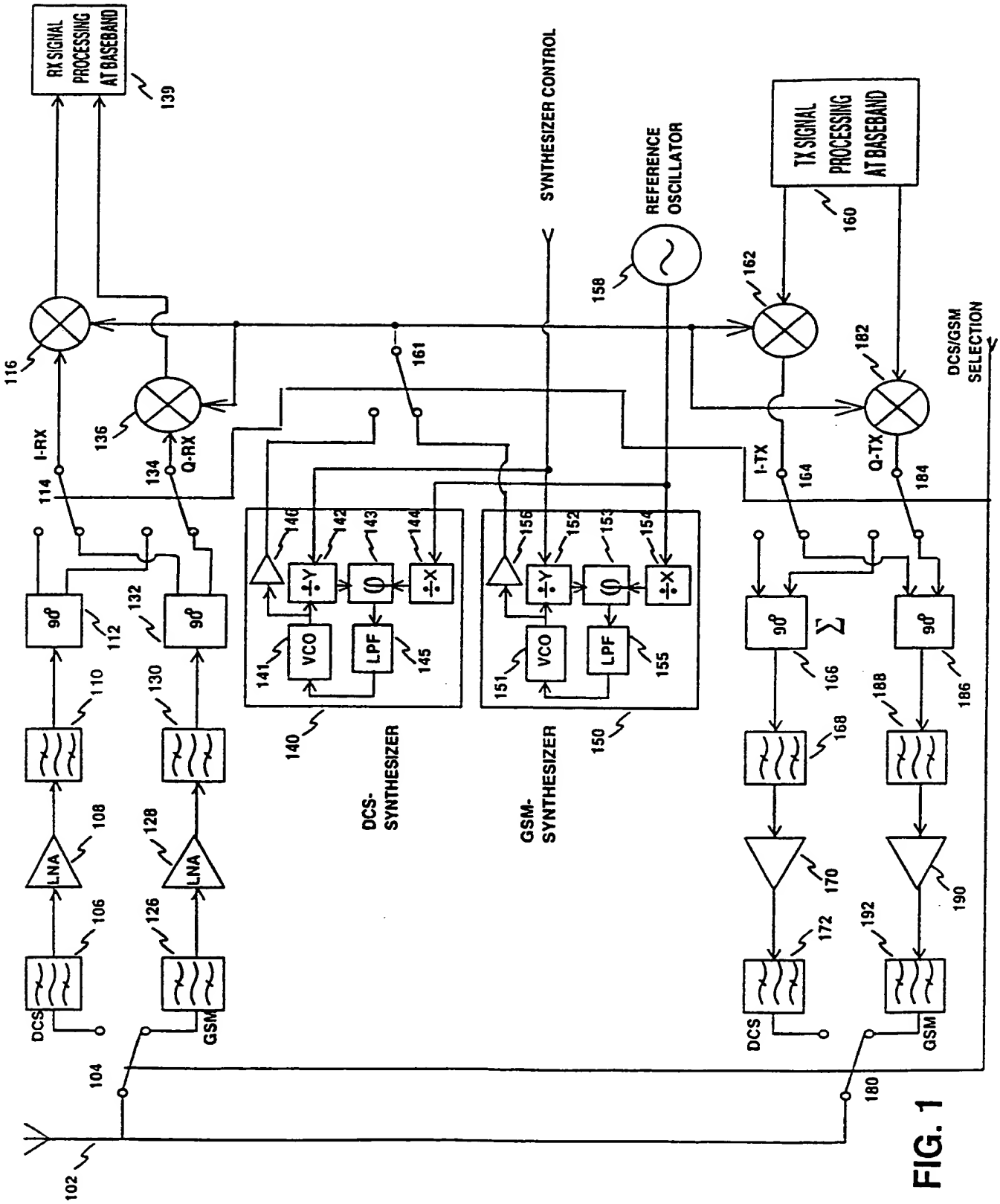
16. The transmitter of claim 15, **characterized** in that said frequency divider is arranged so as to divide the TX synthesizer's output signal always at least by two in order to generate a TX mixing signal.

17. The transmitter of any one of claims 12 to 16, **characterized** in that it comprises means (17, GX3) for controlling the gain of the transmitter amplifier.

18. The transmitter of any one of claims 12 to 17, **characterized** in that it comprises means (18, BX) for controlling the operating frequency band of the transmitter amplifier.

19. The transmitter of any one of claims 12 to 18, **characterized** in that it comprises a bandpass filter for filtering the amplified transmission signal at the carrier frequency, and means for selecting the pass band of the transmitter bandpass filter (3, FX2) so that it corresponds to the transmission frequency.

20. The transmitter of any one of claims 12 to 19, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.


RX SIGNAL PROCESSING AT BASEBAND
139
SYNTHESIZER CONTROL
REFERENCE OSCILLATOR
158
TX SIGNAL PROCESSING AT BASEBAND
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162
116
161
182
DCS/GSM SELECTION
136
I-RX
Q-RX
134
114
I-TX
164
Q-TX
184
90°
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110
130
LNA
108
128
106
126
DCS
GSM
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DCS-SYNTHESIZER
VCO
LPF
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GSM-SYNTHESIZER
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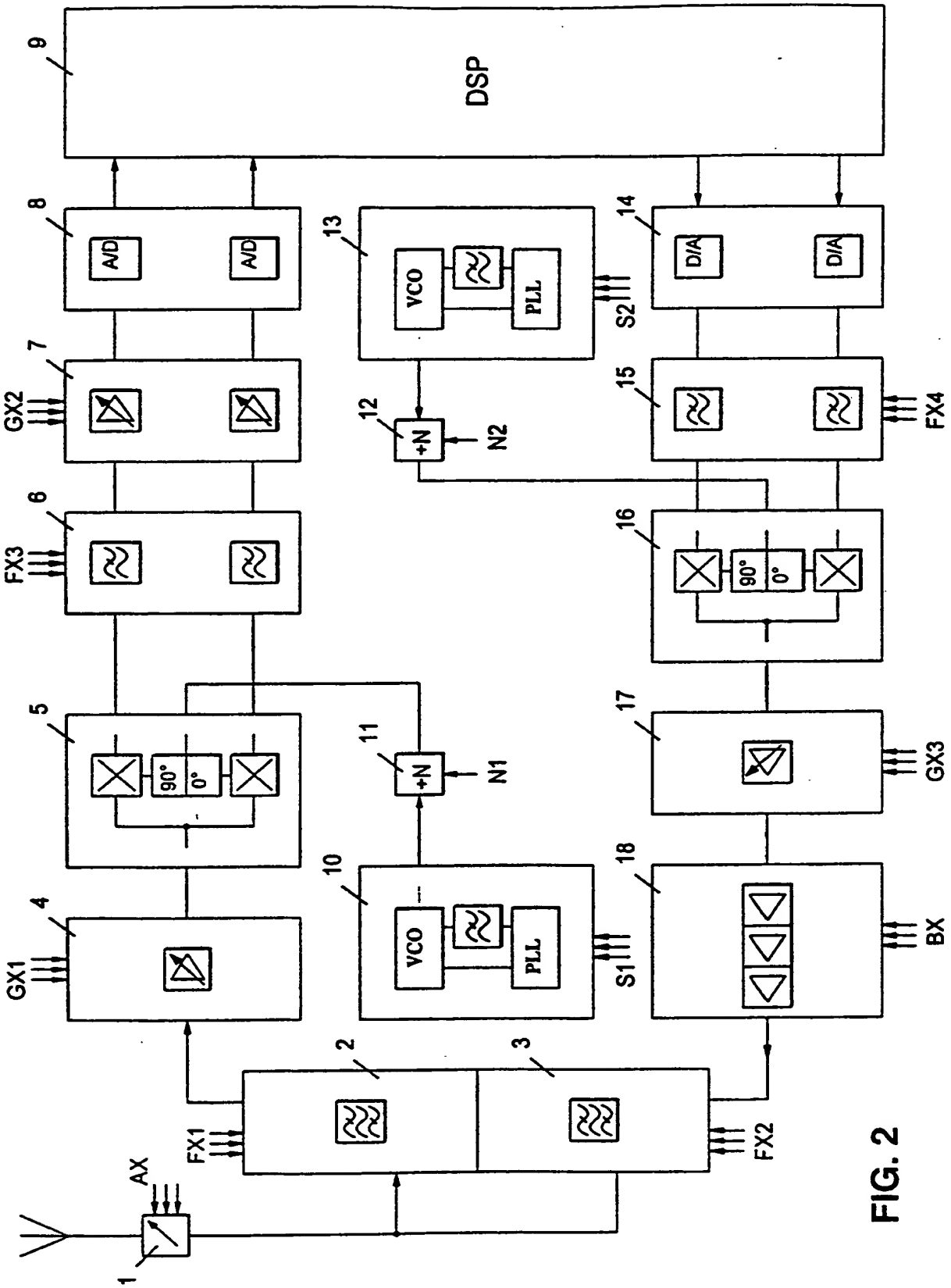
FIG. 1


DSP
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D/A
VCO
PLL
VCO
PLL
+N
+N
N1
N2
90°
0°
90°
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GX1
GX2
GX3
FX1
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FX4
BX
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FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00974

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 1/40, H04B 1/04, H04B 1/16
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 9901933 A2 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 14 January 1999 (14.01.99), see the claims	1,3-11
X	US 4395776 A (YUKIO NAITO ET AL), 26 July 1983 (26.07.83), claims 1-9	2,12-20
X	EP 0633674 A2 (MITSUBUSHI DENKI KABUSHIKI KAISHA), 11 January 1995 (11.01.95), claims 1-9	2,12
X	EP 0813312 A2 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 17 December 1997 (17.12.97), claims 1-3,8, 12	1,3-5,8-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 April 2000	13 -04- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Rune Bengtsson/mj Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/FI 99/00974

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9901933 A2	14/01/99	AU 8135998 A	25/01/99
US 4395776 A	26/07/83	EP 0036431 A,B	30/09/81
		SE 0036431 T3	
		JP 1420478 C	14/01/88
		JP 56047131 A	28/04/81
		JP 62017904 B	20/04/87
		WO 8100942 A	02/04/81
EP 0633674 A2	11/01/95	JP 7022971 A	24/01/95
		US 5548825 A	20/08/96
EP 0813312 A2	17/12/97	CA 2208276 A	10/12/97
		CN 1175176 A	04/03/98
		JP 10065749 A	06/03/98

PCT REQUEST

49190

Original (for SUBMISSION) - printed on 25.11.1999 10:34:06 AM

0	**For receiving Office use only**	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	**Form - PCT/RO/101 PCT Request**	
0-4-1	Prepared using	PCT-EASY Version 2.84 (updated 01.07.1999)
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	National Board of Patents and Registration (Finland) (RO/FI)
0-7	**Applicant's or agent's file reference**	49190
I	**Title of invention**	METHOD AND ARRANGEMENT FOR TRANSMITTING AND RECEIVING RF SIGNALS THROUGH VARIOUS RADIO INTERFACES OF COMMUNICATION SYSTEMS
II	**Applicant**	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	NOKIA MOBILE PHONES LTD.
II-5	Address:	Keilalahdentie 4 FIN-02150 Espoo Finland
II-6	State of nationality	FI
II-7	State of residence	FI
III-1	**Applicant and/or inventor**	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	VÄISÄNEN, Risto
III-1-5	Address:	Vähäsillankatu 10 B 5 FIN-24100 Salo Finland
III-1-6	State of nationality	FI
III-1-7	State of residence	FI

PCT REQUEST

Original (for SUBMISSION) - printed on 25.11.1999 10:34:06 AM

III-2	**Applicant and/or inventor**	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	KALTIOKALLIO, Kim
III-2-5	Address:	Pähkinärinne 4 FIN-24240 Salo Finland
III-2-6	State of nationality	FI
III-2-7	State of residence	FI
IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	BERGGREN OY AB
IV-1-2	Address:	P.O. Box 16 FIN-00101 Helsinki Finland
IV-1-3	Telephone No.	+358-9-693701
IV-1-4	Facsimile No.	+358-9-6933944
IV-1-5	e-mail	email.box@berggren.elisa.fi
V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AL AM AT AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ DE DK DM EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW

PCT REQUEST 49190

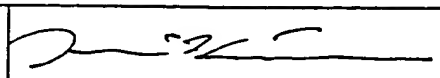
Original (for **SUBMISSION**) - printed on 25.11.1999 10:34:06 AM

V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	**Exclusion(s) from precautionary designations**	NONE	
VI-1	**Priority claim of earlier national application**		
VI-1-1	Filing date	26 November 1998 (26.11.1998)	
VI-1-2	Number	982559	
VI-1-3	Country	FI	
VI-2	**Priority document request** The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	**International Searching Authority Chosen**	Swedish Patent Office (ISA/SE)	
VIII	**Check list**	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	11	-
VIII-3	Claims	3	-
VIII-4	Abstract	1	49190.txt
VIII-5	Drawings	2	-
VIII-7	TOTAL	21	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Copy of Official Action in FI 982559	-
VIII-18	**Figure of the drawings which should accompany the abstract**	2	
VIII-19	**Language of filing of the international application**	English	

PCT REQUEST

49190

Original (for SUBMISSION) - printed on 25.11.1999 10:34:06 AM

IX-1	Signature of applicant or agent	
IX-1-1	Name	BERGGREN OY AB
IX-1-2	Name of signatory	Juhani Kupiainen
IX-1-3	Capacity	Patent Agent

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	

Claims

1. A method for processing signals received from different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a carrier-frequency signal is received from a radio interface,
- the signal at the carrier frequency is bandpass-filtered,
- the filtered signal at the carrier frequency is amplified,
- an RX mixing signal at the receive frequency is generated,
- a complex baseband signal is generated from the received carrier-frequency signal by mixing it with the RX mixing signal,
- the baseband signal generated is low-pass filtered,
- the baseband signal generated is amplified or attenuated prior to analog-to-digital conversion,
- the baseband signal is converted digital, and
- the baseband signal converted digital is processed so as to produce an information signal encoded and modulated into the received signal.

2. A method for processing signals transmitted to different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a digital baseband quadrature signal is generated on the basis of the information signal to be transmitted,
- the digital baseband signal is converted analog,
- a TX mixing signal at the transmit frequency is generated,
- a carrier-frequency transmission signal is generated from the baseband signal by mixing it with the TX mixing signal,
- the carrier-frequency signal generated is amplified, and
- the transmission signal is transmitted to the radio interface.

3. A direct-conversion receiver operating at different radio interfaces of communication systems, **characterized** in that it comprises
- antenna means for receiving a carrier-frequency signal from a radio interface,
- bandpass filter (2) for filtering the carrier-frequency signal,
- first receiver amplifier (4) for amplifying the filtered carrier-frequency signal,
- means (10, 11) for generating an RX mixing signal at the receive frequency,
- mixing means (5) for generating a complex baseband signal from the received signal by means of the RX mixing signal,
- low-pass filter (6) for filtering the baseband signal,
- second amplifier (7) for amplifying the baseband signal,
- analog-to-digital converter (8) for converting the baseband signal digital, and

- means (9) for processing the baseband signal converted digital so as to produce an information signal encoded and modulated into the received signal.

4. The receiver of claim 3, **characterized** in that it comprises means for selecting the pass band of the bandpass filter (2, FX1) such that it corresponds to the receive frequency.

5. The receiver of claim 3 or 4, **characterized** in that it comprises means for controlling the gain of said first amplifier.

6. The receiver of any one of claims 3 to 5, **characterized** in that the means (10, 11) for generating a mixing signal at the receive frequency comprises an RX synthesizer (10, S1) and controllable frequency divider (11, N1) for dividing the frequency of the output signal generated by the RX synthesizer.

7. The receiver of claim 6, **characterized** in that said frequency divider is arranged so as to divide the output signal of the RX synthesizer always by at least two in order to generate an RX mixing signal.

8. The receiver of any one of claims 3 to 7, **characterized** in that it comprises means (6, FX3) for controlling the cut-off frequency of low-pass filtering in order to perform channel filtering according to the selected radio interface.

9. The receiver of any one of claims 3 to 8, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

10. The receiver of any one of claims 3 to 9, **characterized** in that it comprises means (7, GX2) for controlling the gain of the second amplifier.

11. The receiver of any one of claims 3 to 10, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.

12. A direct-conversion transmitter operating at different radio interfaces of communication systems, **characterized** in that it comprises
- means (9) for generating a digital baseband quadrature signal on the basis of the information signal to be transmitted,
- digital-to-analog converter (14) for converting the baseband transmission signal analog,
- synthesizer (10, 11) for generating a TX mixing signal at the transmit frequency,

- mixing means (16) for producing a signal at the carrier frequency from the base-band transmission signal by means of the TX mixing signal,
- transmitter amplifier (7, 8) for amplifying the signal at the carrier frequency, and
- antenna means for transmitting the amplified transmission signal at the carrier frequency.

13. The transmitter of claim 12, **characterized** in that it comprises a controllable low-pass filter (15, FX4) for filtering a baseband transmission signal in order to perform channel filtering according to the radio interface selected.

14. The transmitter of claim 12 or 13, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

15. The transmitter of claim 12, 13 or 14, **characterized** in that the means (10, 11) for generating a TX mixing signal at the transmit frequency comprises a TX synthesizer (13, S2) and controllable frequency divider (12, N2) for dividing the frequency of the output signal generated by the TX synthesizer.

16. The transmitter of claim 15, **characterized** in that said frequency divider is arranged so as to divide the TX synthesizer's output signal always at least by two in order to generate a TX mixing signal.

17. The transmitter of any one of claims 12 to 16, **characterized** in that it comprises means (17, GX3) for controlling the gain of the transmitter amplifier.

18. The transmitter of any one of claims 12 to 17, **characterized** in that it comprises means (18, BX) for controlling the operating frequency band of the transmitter amplifier.

19. The transmitter of any one of claims 12 to 18, **characterized** in that it comprises a bandpass filter for filtering the amplified transmission signal at the carrier frequency, and means for selecting the pass band of the transmitter bandpass filter (3, FX2) so that it corresponds to the transmission frequency.

20. The transmitter of any one of claims 12 to 19, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 49190	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI99/00974	International filing date *(day/month/year)* 25.11.1999	Priority date *(day/month/year)* 26.11.1998
International Patent Classification (IPC) or national classification and IPC7 H 04 B 1/40		
Applicant Nokia Mobile Phones Ltd. et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☒ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
22.06.2000	12.03.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Telex 17978 PATOREG-S Facsimile No. 08-667 72 88	Authorized officer Åsa Hällgren/mj Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00974

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed

☒ the description:
pages 1-11 , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☒ the claims:
pages _____ , as originally filed
pages _____ , as amended (together with any statement) under article 19
pages _____ , filed with the demand
pages 12-15 , filed with the letter of 05.02.2001

☒ the drawings:
pages 1-2 , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☐ the sequence listing part of the description:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims		NO
Inventive step (IS)	Claims	1-20	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The claimed invention presents a receiver, a transmitter and a method for processing signals in different frequency bands e.g. in the GSM and DCS frequency bands. The aim of the invention is solve the problem of providing a simple solution for realising a programmable transceiver. The problem is solved by performing signal processing using one and the same signal processing line regardless of which type of signal, e.g. GSM or DCS, that is being processed.

The international search has resulted in the following relevant documents:

D1: WO9901933
D2: US4395776
D3: EP0633674
D4: EP0813312

A new search has resulted in the following, more relevant document, of which the priority document (FI100286) is cited in the application:

D5: EP 0800283

Document D1 is published after the priority date.

Documents D2, D3 and D4 do not show the invention.

Document D5 shows a direct-conversion transmitter and receiver for transmitting and receiving of RF signals in two frequency-bands, e.g. GSM or DCS.

.../...

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PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

JKIAH

To:

BERGGREN OY ~~AB~~ Berggren Oy Ab
P.O. Box 16
FIN-00101 Helsinki 28 -02- 2000
FINLANDE

Date of mailing (day/month/year) 18 February 2000 (18.02.00)	
Applicant's or agent's file reference 49190	**IMPORTANT NOTIFICATION**
International application No. PCT/FI99/00974	International filing date (day/month/year) 25 November 1999 (25.11.99)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 26 November 1998 (26.11.98)
Applicant NOKIA MOBILE PHONES LTD. et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
26 Nove 1998 (26.11.98)	982559	FI	15 Febr 2000 (15.02.00)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Marc Salzman

Telephone No. (41-22) 338.83.38

WO 00/31885
PCT/FI99/00974

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:
BERGGREN OY AB
P.O. Box 16
FIN-00101 Helsinki
FINLANDE

Berggren Oy Ab
12 -06- 2000
AH/JK

Date of mailing (day/month/year) 02 June 2000 (02.06.00)	
Applicant's or agent's file reference 49190	**IMPORTANT NOTICE**
International application No. PCT/FI99/00974	**International filing date** (day/month/year) 25 November 1999 (25.11.99)
Priority date (day/month/year) 26 November 1998 (26.11.98)	
Applicant NOKIA MOBILE PHONES LTD. et al	

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,CN,JP,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CR,CU,CZ,DE,DK,DM,EA,EE,EP,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MN,MW,MX,NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   02 June 2000 (02.06.00) under No. WO 00/31885

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer
J. Zahra

Telephone No. (41-22) 338.83.38

Continuation of Form PCT/IB/308

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

Date of mailing (day/month/year)	IMPORTANT NOTICE
02 June 2000 (02.06.00)	
Applicant's or agent's file reference	**International application No.**
49190	PCT/FI99/00974

The applicant is hereby notified that, at the time of establishment of this Notice, the time limit under Rule 46.1 for making amendments under Article 19 has not yet expired and the International Bureau had received neither such amendments nor a declaration that the applicant does not wish to make amendments.

PATENT COOPERATION TREATY

JK/AH

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Berggren Oy Ab
P.O. Box 16
FIN-00101 HELSINKI
Finland

Berggren Oy Ab
28 -06- 2000

PCT

NOTIFICATION OF RECEIPT OF DEMAND BY COMPETENT INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rules 59.3(e) and 61.1(b), first sentence and Administrative Instructions, Section 601(a))

Date of mailing *(day/month/year)*: 2000 -06- 22

Applicant's or agent's file reference: 49190

IMPORTANT NOTIFICATION

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI99/00974	25-11-1999	26-11-1998

Applicant: Nokia Mobile Phones Ltd.
et al

1. The applicant is hereby notified that this International Preliminary Examining Authority considers the following date as the date of receipt of the demand for international preliminary examination of the international application:

   22-06-2000

2. This date of receipt is:

   [X] the actual date of receipt of the demand by this Authority (Rule 61.1(b)).

   [ ] the actual date of receipt of the demand on behalf of this Authority (Rule 59.3(e)).

   [ ] the date on which this Authority has, in response to the invitation to correct defects in the demand (Form PCT/IPEA/404), received the required corrections.

3. [ ] ATTENTION: That date of receipt is AFTER the expiration of 19 months from the priority date. Consequently, the election(s) made in the demand does (do) not have the effect of postponing the entry into the national phase until 30 months from the priority date (or later in some Offices) (Article 39(1)). Therefore, the acts for entry into the national phase must be performed within 20 months from the priority date (or later in some Offices) (Article 22). For details, see the *PCT Applicant's Guide*, Volume II.

   [ ] *(If applicable)* This notificaton confirms the information given by telephone, facsimile transmission or in person on:

4. Only where paragraph 3 applies, a copy of this notification has been sent to the International Bureau.

Name and mailing address of the IPEA/
Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM
Facsimile No. 08-667 72 88

Telex
17978
PATOREG-S

Authorized officer: Pernilla Hjerth

Telephone No. 08-782 25 00

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Berggren Oy Ab
P.O. Box 16 Berggren Oy Ab
FIN-00101 HELSINKI 14-12-2000
Finland

PCT

WRITTEN OPINION

(PCT Rule 66)

PR: 26.1.01
OHS: 11.1.01

Applicant's or agent's file reference 49190	Date of mailing *(day/month/year)* 14-12-2000 **REPLY DUE** within 45 days from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI99/00974	25.11.1999	26.11.1998

International Patent Classification (IPC) or both national classification and IPC7
H 04 B 1/40

Applicant
Nokia Mobile Phones Ltd. et al.

1. This written opinion is the first (first, etc.) drawn by this International Preliminary Examining Authority.
2. This opinion contains indications relating to the following items:
   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☒ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application
3. The applicant is hereby **invited to reply** to this opinion.
   - **When?** See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).
   - **How?** By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.
   - **Also** For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4*bis*. For an informal communication with the examiner, see Rule 66.6.

   If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.
4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 26.03.2001

Name and mailing address of the IPEA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Peder Gjervaldsaeter/AE Telephone No. 08-782 25 00

Form PCT/IPEA/408 (cover sheet) (January 1998)

WRITTEN OPINION

International application No.
PCT/FI99/00974

I. Basis of the opinion

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".*

WRITTEN OPINION

International application No.
PCT/FI99/00974

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1,3-11	YES
	Claims	2,12-20	NO
Inventive step (IS)	Claims		YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims		NO

2. Citations and explanations

The claimed invention presents a receiver, a transmitter and a method for processing signals in different frequency bands e.g. in the GSM and DCS frequency bands. The aim of the invention is solve the problem of providing a simple solution for realising a programmable transceiver. The problem is solved by performing signal processing using one and the same signal processing line regardless of which type of signal, e.g. GSM or DCS, that is being processed.

The international search has resulted in the following relevant documents:

D1: WO9901933
D2: US4395776
D3: EP0633674
D4: EP0813312

A new search has resulted in the following, more relevant document, of which you have cited the priority document (FI100286) in your application:

D5: EP 0800283

Document D1 is published after the priority date.

Documents D2, D3 and D4 do not show the invention.

Document D5 shows a direct-conversion transmitter and receiver for transmitting and receiving of RF signals in two frequency-bands, e.g. GSM or DCS. Here, however, are different signal processing lines used for the two frequency-bands respectively.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V.

In the independent claims 1-3 and 12 it is not clearly stated that one single signal processing path is used for the processing of signals in different frequency bands.

Claim 1 refers to a method for processing signals received from "different radio interfaces" and claim 3 refers to a direct-conversion receiver. Of all the characteristics presented in these claims are all except that the baseband signal is low-pass filtered after generation to be found in D5 (column 2, line 31-35 and line 49-52; claim 1). Since using a low-pass filter instead of a band-pass filter does not lead to any unexpected technical effects, this is not considered to constitute an inventive step. Claim 1 and claim 3 therefore lack inventive step.

Claim 2 refers to a method for processing signals transmitted to "different radio interfaces" and claim 12 refers to a direct-conversion transmitter. All the characteristics presented in these claims can be found in D5 (column 3, line 44-46 and line 51-54; claim 1). Claim 2 and claim 12 therefore lack novelty.

Claims 6-7 and 15-16 refer to the use of a signal synthesiser and a frequency divider. These components - used in a similar way as in said claims - are mentioned in D5 (column 4, line 22-25; column 10, line 37-50). Therefore claims 6-7 and 15-16 are considered to lack an inventive step.

Dependent claims 4-5, 8-11, 13-14 and 17-20 define numerous additional features, many of which are known from the cited prior art or are merely considered straight forward design options for signal processing in a communication system.

WRITTEN OPINION

International application No.
PCT/FI99/00974

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
WO 9901933	14.01.1999	23.06.1998	01.07.1997

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The use of the expression "different radio interfaces" is vague when meaning different frequency bands.

The formulation "A method for processing signals transmitted to diff.." in claim 2 gives the impression that the signal is processed at the receiver side.

PATENTTI- JA REKISTERIHALLITUS
Patentti- ja innovaatiolinja

TUTKIMUSRAPORTTI

PATENTTIHAKEMUS NRO	LUOKITUS
982559	H04B1/38, H04B7/26, H0N5/455, H04N5/445, H04L27/38, H04L27/36

TUTKITTU AINEISTO

Patenttijulkaisukokoelma (FI, SE, NO, DK, DE, CH, EP, WO, GB, US), tutkitut luokat

H04B1/38, H04B1/40, H04B7/26, H04N5/455, H04N5/445, H04L27/38, H04L27/36

Tiedonhaut ja muu aineisto

EPOQUE tietokannat: EPODOC, WPI, PAJ

Fulltext tietokannat: englantilainen, saksalainen, ranskalainen

IEL On-line tietokannat: julkaisut, konferenssit, standardit

VIITEJULKAISUT

Kategoria*)	Julkaisun tunnistetiedot	Koskee vaatimuksia
Y	ICCT'98, 22-24.10.1998, State Key Lab on Microwave & Digital Communications	1,2,3,6,8,9,11, 12,15,18,20
A	EP-A-0798880, H04B7/22, Nokia Mobile Phones Ltd.	1,2,3,11,12,20
Y	EP-A-0809366, H04B7/26, LSI Logic Corporation	1,2,3,11,12,20
Y	EP-A-0581573, H04B1/40, Nokia Mobile Phones Ltd.	1,2,6,7,11,15
Y	US-A-5794119, H04B1/00, Stanford Telecomminications, Inc.	1,2,3,12,20

*) X Patentoitavuuden kannalta merkittävä julkaisu yksinään tarkasteltuna
Y Patentoitavuuden kannalta merkittävä julkaisu, kun otetaan huomioon tämä ja yksi tai useampi samaan kategoriaan kuuluva julkaisu
A Yleistä tekniikan tasoa edustava julkaisu, ei kuitenkaan patentoitavuuden este

Päiväys	Tutkija
16.11.1999	Jari Rantala

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 49190	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/FI 99/00974	International filing date *(day/month/year)* 25 November 1999	(Earliest) Priority Date *(day/month/year)* 26 November 1998
Applicant Nokia Mobile Phones Ltd. et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

[x] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] Certain claims were found unsearchable (See Box I).

2. [ ] Unity of invention is lacking (See Box II).

3. [ ] The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] transcribed by this Authority.

4. With regard to the title,
   - [x] the text is approved as submitted by the applicant.
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the abstract,
   - [x] the text is approved as submitted by the applicant.
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is:
   Figure No. 2
   - [x] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00974

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 1/40, H04B 1/04, H04B 1/16
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 9901933 A2 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 14 January 1999 (14.01.99), see the claims --	1,3-11
X	US 4395776 A (YUKIO NAITO ET AL), 26 July 1983 (26.07.83), claims 1-9 --	2,12-20
X	EP 0633674 A2 (MITSUBUSHI DENKI KABUSHIKI KAISHA), 11 January 1995 (11.01.95), claims 1-9 --	2,12
X	EP 0813312 A2 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 17 December 1997 (17.12.97), claims 1-3,8, 12 --	1,3-5,8-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 April 2000	13 -04- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM	Authorized officer

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/12/99

International application No.
PCT/FI 99/00974

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9901933 A2	14/01/99	AU 8135998 A	25/01/99
US 4395776 A	26/07/83	EP 0036431 A,B	30/09/81
		SE 0036431 T3	
		JP 1420478 C	14/01/88
		JP 56047131 A	28/04/81
		JP 62017904 B	20/04/87
		WO 8100942 A	02/04/81
EP 0633674 A2	11/01/95	JP 7022971 A	24/01/95
		US 5548825 A	20/08/96
EP 0813312 A2	17/12/97	CA 2208276 A	10/12/97
		CN 1175176 A	04/03/98
		JP 10065749 A	06/03/98

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

In the independent claims 1-3 and 12 it is clearly stated that one single signal processing path is used for the processing of signals in different frequency bands. None of the above listed documents include this technical feature, wherefore the invention claimed in claims 1-20 is considered to be novel and to include an inventive step.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00974

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
WO 9901933	14.01.1999	23.06.1998	01.07.1997

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The use of the expression "different radio interfaces" is vague when meaning different frequency bands.

The formulation "A method for processing signals transmitted to diff.." in claim 2 gives the impression that the signal is processed at the receiver side.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
49190		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI99/00974	25.11.1999	26.11.1998
International Patent Classification (IPC) or national classification and IPC7		
H 04 B 1/40		
Applicant		
Nokia Mobile Phones Ltd. et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
22.06.2000	12.03.2001
Name and mailing address of the IPEA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Åsa Hällgren/mj Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00974

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed

☒ the description:
pages 1-11 , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☒ the claims:
pages _____ , as originally filed
pages _____ , as amended (together with any statement) under article 19
pages _____ , filed with the demand
pages 12-15 , filed with the letter of 05.02.2001

☒ the drawings:
pages 1-2 , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☐ the sequence listing part of the description:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00974

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims		NO
Inventive step (IS)	Claims	1-20	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The claimed invention presents a receiver, a transmitter and a method for processing signals in different frequency bands e.g. in the GSM and DCS frequency bands. The aim of the invention is solve the problem of providing a simple solution for realising a programmable transceiver. The problem is solved by performing signal processing using one and the same signal processing line regardless of which type of signal, e.g. GSM or DCS, that is being processed.

The international search has resulted in the following relevant documents:

D1: WO9901933
D2: US4395776
D3: EP0633674
D4: EP0813312

A new search has resulted in the following, more relevant document, of which the priority document (FI100286) is cited in the application:

D5: EP 0800283

Document D1 is published after the priority date.

Documents D2, D3 and D4 do not show the invention.

Document D5 shows a direct-conversion transmitter and receiver for transmitting and receiving of RF signals in two frequency-bands, e.g. GSM or DCS.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

In the independent claims 1-3 and 12 it is clearly stated that one single signal processing path is used for the processing of signals in different frequency bands. None of the above listed documents include this technical feature, wherefore the invention claimed in claims 1-20 is considered to be novel and to include an inventive step.

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
WO 9901933	14.01.1999	23.06.1998	01.07.1997

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The use of the expression "different radio interfaces" is vague when meaning different frequency bands.

The formulation "A method for processing signals transmitted to diff.." in claim 2 gives the impression that the signal is processed at the receiver side.

PCT/FI 99/00974
05 -02- 2001

Claims

1. A method for processing signals received from different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a carrier-frequency signal is received from a radio interface,
- the signal at the carrier frequency is bandpass-filtered,
- the filtered signal at the carrier frequency is amplified,
- an RX mixing signal at the receive frequency is generated,
- a complex baseband signal is generated from the received carrier-frequency signal by mixing it with the RX mixing signal,
- the baseband signal generated is low-pass filtered,
- the baseband signal generated is amplified or attenuated prior to analog-to-digital conversion,
- the baseband signal is converted digital, and
- the baseband signal converted digital is processed so as to produce an information signal encoded and modulated into the received signal,

wherein the signal prosessing parts for processing receive frequency signal are common for signals received from at least two different radio interfaces.

2. A method for processing signals transmitted to different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a digital baseband quadrature signal is generated on the basis of the information signal to be transmitted,
- the digital baseband signal is converted analog,
- a TX mixing signal at the transmit frequency is generated,
- a carrier-frequency transmission signal is generated from the baseband signal by mixing it with the TX mixing signal,
- the carrier-frequency signal generated is amplified, and
- the transmission signal is transmitted to the radio interface,

wherein the signal prosessing parts for processing transmit frequency signal are common for signals received from at least two different radio interfaces.

3. A direct-conversion receiver operating at different radio interfaces of communication systems, **characterized** in that it comprises

- antenna means for receiving a carrier-frequency signal from a radio interface,
- bandpass filter (2) for filtering the carrier-frequency signal,
- first receiver amplifier (4) for amplifying the filtered carrier-frequency signal,
- means (10, 11) for generating an RX mixing signal at the receive frequency,

- mixing means (5) for generating a complex baseband signal from the received signal by means of the RX mixing signal,
- low-pass filter (6) for filtering the baseband signal,
- second amplifier (7) for amplifying the baseband signal,
- analog-to-digital converter (8) for converting the baseband signal digital, and
- means (9) for processing the baseband signal converted digital so as to produce an information signal encoded and modulated into the received signal,

wherein the signal prosessing parts for processing receive frequency signal are common for signals received from at least two different radio interfaces.

4. The receiver of claim 3, **characterized** in that it comprises means for selecting the pass band of the bandpass filter (2, FX1) such that it corresponds to the receive frequency.

5. The receiver of claim 3 or 4, **characterized** in that it comprises means for controlling the gain of said first amplifier.

6. The receiver of any one of claims 3 to 5, **characterized** in that the means (10, 11) for generating a mixing signal at the receive frequency comprises an RX synthesizer (10, S1) and controllable frequency divider (11, N1) for dividing the frequency of the output signal generated by the RX synthesizer.

7. The receiver of claim 6, **characterized** in that said frequency divider is arranged so as to divide the output signal of the RX synthesizer always by at least two in order to generate an RX mixing signal.

8. The receiver of any one of claims 3 to 7, **characterized** in that it comprises means (6, FX3) for controlling the cut-off frequency of low-pass filtering in order to perform channel filtering according to the selected radio interface.

9. The receiver of any one of claims 3 to 8, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

10. The receiver of any one of claims 3 to 9, **characterized** in that it comprises means (7, GX2) for controlling the gain of the second amplifier.

11. The receiver of any one of claims 3 to 10, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.

12. A direct-conversion transmitter operating at different radio interfaces of communication systems, **characterized** in that it comprises
- means (9) for generating a digital baseband quadrature signal on the basis of the information signal to be transmitted,
- digital-to-analog converter (14) for converting the baseband transmission signal analog,
- synthesizer (10, 11) for generating a TX mixing signal at the transmit frequency,
- mixing means (16) for producing a signal at the carrier frequency from the baseband transmission signal by means of the TX mixing signal,
- transmitter amplifier (7, 8) for amplifying the signal at the carrier frequency, and
- antenna means for transmitting the amplified transmission signal at the carrier frequency,

wherein the signal prosessing parts for processing transmit frequency signal are common for signals received from at least two different radio interfaces.

13. The transmitter of claim 12, **characterized** in that it comprises a controllable low-pass filter (15, FX4) for filtering a baseband transmission signal in order to perform channel filtering according to the radio interface selected.

14. The transmitter of claim 12 or 13, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

15. The transmitter of claim 12, 13 or 14, **characterized** in that the means (10, 11) for generating a TX mixing signal at the transmit frequency comprises a TX synthesizer (13, S2) and controllable frequency divider (12, N2) for dividing the frequency of the output signal generated by the TX synthesizer.

16. The transmitter of claim 15, **characterized** in that said frequency divider is arranged so as to divide the TX synthesizer's output signal always at least by two in order to generate a TX mixing signal.

17. The transmitter of any one of claims 12 to 16, **characterized** in that it comprises means (17, GX3) for controlling the gain of the transmitter amplifier.

18. The transmitter of any one of claims 12 to 17, **characterized** in that it comprises means (18, BX) for controlling the operating frequency band of the transmitter amplifier.

19. The transmitter of any one of claims 12 to 18, **characterized** in that it comprises a bandpass filter for filtering the amplified transmission signal at the

carrier frequency, and means for selecting the pass band of the transmitter bandpass filter (3, FX2) so that it corresponds to the transmission frequency.

20. The transmitter of any one of claims 12 to 19, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.

Berggren
PATENTTITOIMISTO • PATENT & TRADEMARK ATTORNEYS

5 February 2001
VIA FACSIMILE (13 pages)
Original by mail

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Authorized Officer: Peder Gjervaldsaeter/AE
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REPLY TO WRITTEN OPINION
INTERNATIONAL PATENT APPLICATION PCT/FI99/00974
APPLICANT: NOKIA MOBILE PHONES LTD.
DUE DATE: 9 FEBRUARY 2001

This is a response to the Written Opinion mailed on 12.12.2000.

We file new claims in which the independent claims now include the feature of processing the signals of receive/transmit frequency with the processing parts, which are common for at least two radio interfaces.

The applicant expects the new claims to be novel and inventive over the prior art, as was implied in the Written Opinion.

BERGGREN OY AB

Juhani Kupiainen
Patent Agent

Encls a set of new claims 1 to 20 in triplicate

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Claims

1. A method for processing signals received from different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a carrier-frequency signal is received from a radio interface,
- the signal at the carrier frequency is bandpass-filtered,
- the filtered signal at the carrier frequency is amplified,
- an RX mixing signal at the receive frequency is generated,
- a complex baseband signal is generated from the received carrier-frequency signal by mixing it with the RX mixing signal,
- the baseband signal generated is low-pass filtered,
- the baseband signal generated is amplified or attenuated prior to analog-to-digital conversion,
- the baseband signal is converted digital, and
- the baseband signal converted digital is processed so as to produce an information signal encoded and modulated into the received signal,
wherein the signal prosessing parts for processing receive frequency signal are common for signals received from at least two different radio interfaces.

2. A method for processing signals transmitted to different radio interfaces of communication systems, **characterized** in that it comprises steps in which
- a digital baseband quadrature signal is generated on the basis of the information signal to be transmitted,
- the digital baseband signal is converted analog,
- a TX mixing signal at the transmit frequency is generated,
- a carrier-frequency transmission signal is generated from the baseband signal by mixing it with the TX mixing signal,
- the carrier-frequency signal generated is amplified, and
- the transmission signal is transmitted to the radio interface,
wherein the signal prosessing parts for processing transmit frequency signal are common for signals received from at least two different radio interfaces.

3. A direct-conversion receiver operating at different radio interfaces of communication systems, **characterized** in that it comprises

- antenna means for receiving a carrier-frequency signal from a radio interface,
- bandpass filter (2) for filtering the carrier-frequency signal,
- first receiver amplifier (4) for amplifying the filtered carrier-frequency signal,
- means (10, 11) for generating an RX mixing signal at the receive frequency,

- mixing means (5) for generating a complex baseband signal from the received signal by means of the RX mixing signal,
- low-pass filter (6) for filtering the baseband signal,
- second amplifier (7) for amplifying the baseband signal,
- analog-to-digital converter (8) for converting the baseband signal digital, and
- means (9) for processing the baseband signal converted digital so as to produce an information signal encoded and modulated into the received signal,

wherein the signal prosessing parts for processing receive frequency signal are common for signals received from at least two different radio interfaces.

4. The receiver of claim 3, **characterized** in that it comprises means for selecting the pass band of the bandpass filter (2, FX1) such that it corresponds to the receive frequency.

5. The receiver of claim 3 or 4, **characterized** in that it comprises means for controlling the gain of said first amplifier.

6. The receiver of any one of claims 3 to 5, **characterized** in that the means (10, 11) for generating a mixing signal at the receive frequency comprises an RX synthesizer (10, S1) and controllable frequency divider (11, N1) for dividing the frequency of the output signal generated by the RX synthesizer.

7. The receiver of claim 6, **characterized** in that said frequency divider is arranged so as to divide the output signal of the RX synthesizer always by at least two in order to generate an RX mixing signal.

8. The receiver of any one of claims 3 to 7, **characterized** in that it comprises means (6, FX3) for controlling the cut-off frequency of low-pass filtering in order to perform channel filtering according to the selected radio interface.

9. The receiver of any one of claims 3 to 8, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

10. The receiver of any one of claims 3 to 9, **characterized** in that it comprises means (7, GX2) for controlling the gain of the second amplifier.

11. The receiver of any one of claims 3 to 10, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.

12. A direct-conversion transmitter operating at different radio interfaces of communication systems, **characterized** in that it comprises
- means (9) for generating a digital baseband quadrature signal on the basis of the information signal to be transmitted,
- digital-to-analog converter (14) for converting the baseband transmission signal analog,
- synthesizer (10, 11) for generating a TX mixing signal at the transmit frequency,
- mixing means (16) for producing a signal at the carrier frequency from the baseband transmission signal by means of the TX mixing signal,
- transmitter amplifier (7, 8) for amplifying the signal at the carrier frequency, and
- antenna means for transmitting the amplified transmission signal at the carrier frequency,
wherein the signal prosessing parts for processing transmit frequency signal are common for signals received from at least two different radio interfaces.

13. The transmitter of claim 12, **characterized** in that it comprises a controllable low-pass filter (15, FX4) for filtering a baseband transmission signal in order to perform channel filtering according to the radio interface selected.

14. The transmitter of claim 12 or 13, **characterized** in that it comprises means for implementing channel filtering realized in a digital manner.

15. The transmitter of claim 12, 13 or 14, **characterized** in that the means (10, 11) for generating a TX mixing signal at the transmit frequency comprises a TX synthesizer (13, S2) and controllable frequency divider (12, N2) for dividing the frequency of the output signal generated by the TX synthesizer.

16. The transmitter of claim 15, **characterized** in that said frequency divider is arranged so as to divide the TX synthesizer's output signal always at least by two in order to generate a TX mixing signal.

17. The transmitter of any one of claims 12 to 16, **characterized** in that it comprises means (17, GX3) for controlling the gain of the transmitter amplifier.

18. The transmitter of any one of claims 12 to 17, **characterized** in that it comprises means (18, BX) for controlling the operating frequency band of the transmitter amplifier.

19. The transmitter of any one of claims 12 to 18, **characterized** in that it comprises a bandpass filter for filtering the amplified transmission signal at the

carrier frequency, and means for selecting the pass band of the transmitter bandpass filter (3, FX2) so that it corresponds to the transmission frequency.

20. The transmitter of any one of claims 12 to 19, **characterized** in that the signal processing path comprises substantially the same components for connecting to the different radio interfaces.